flow persists. Thus far we have found no evidence of the existence of a liquid-crystalline phase in the near-surface region. This experimental observation does not seem to fit into any of the theoretical frameworks developed thus far for the instabilities, including the surface-dominated mechanism.

EPILOGUE
What started nearly thirty years ago as a classical continuum problem has evolved into a study of molecular interactions at surfaces, in my laboratory (which I have emphasized here) and others. We are following this path because our ability to study real processing problems at a molecular level is enhanced by tools which were previously unknown or unfamiliar to us.

Our goal is unchanged from what it was when we began, but our methodology is quite different. My students are routinely using a variety of surface-sensitive methods (those mentioned above and other microscopes and spectroscopies) to study the mechanics of polymer interfaces, as are those in other laboratories. My colleagues Arup Chakraborty and Doros Theodorou, and their counterparts elsewhere, are using powerful computational and theoretical methods to study polymer chain conformations and dynamics near surfaces because of their own interests in a variety of practical problems.

I believe a thorough understanding of polymer surface interactions will result in major advances in processing, not just in problems of extrusion instability but, more importantly, in our ability to tailor surfaces for specific processing functions. I remain convinced that many of the extrusion instabilities which we have been studying (for I do not believe there is just one, despite the common onset at about the same recoverable shear) are the result of surface interactions, and that this is a fruitful avenue for research. It is likely that other mechanisms (stress-induced phase transitions, for example) are also important, and the recurrent danger is to become so focused on one idea that we miss other possibilities. We have done this too often in the past.

ACKNOWLEDGMENT
My recent studies of polymer interfaces have been carried out through a program in the Center for Advanced Materials at the Lawrence Berkeley Laboratory, supported in part by the Director, Office of Energy Research, Office of Basic Energy Sciences, Materials Science Division of the U. S. Department of Energy, under Contract No. DE-AC03-76SF00098.

REFERENCES
delightful treat to readers with deeper mathematical interests and is likely to draw the attention of researchers in applied mathematics, as it has done in the analogous fields of elastostatics and elasto-dynamics. Furthermore, readers with an interest in the field of computational science will be intrigued by the discussion of advanced computational procedures for solving the integral equations describing flow past collections of particles with reference to parallel computation.

The book consists of nineteen chapters and is divided into four parts according to geometrical configuration. Each section is followed by exercises with varying degrees of difficulty, with the objective of supplementing and extending the theory and filling in the details.

Part I, "Governing Equations and Fundamental Theorems," introduces the equations governing creeping flow with suspended particles. It contains the first two chapters: "Microhydrodynamic Phenomena," and "General Properties and Fundamental Theorems." Uniqueness of solution, energy dissipation theorems and their application to estimate the forces exerted on particles, the boundary integral representation, and the mathematical origin of the multi-pole expansion method are discussed.

Part II focuses on the "Dynamics of a Single Particle." Exact and asymptotic solutions are presented via singularity and functional expansion methods in spherical coordinates, and the mobility and resistivity problems are defined. This part concludes with a chapter on unsteady Stokes flow or linearized Navier-Stokes flow that contains some original contributions and indicates avenues for further development.

Part III considers "Hydrodynamic Interactions" (that is, flows in the presence of two or more suspended particles) and outlines methods for computing mutual hydrodynamic effects. The resistance and mobility problems for multi-particle systems are formalized, an instructive discussion of the method of reflections for well-separated particles is presented, and asymptotic methods for well-separated particles and particles with disparate sizes are discussed. Furthermore, the two-sphere problem is analyzed in an exhaustively manner. The last chapter in this part introduces the application of numerical methods to compute creeping flow in the context of the multi-pole collocation method.

Part IV is dedicated to developing and solving the integral equations that describe flow in a container with suspended particles. The five chapters in this part are grouped under the general heading "Foundations of Parallel Computational Microhydrodynamics." The properties of the integral equations arising from boundary integral representations of Stokes flow are discussed in detail, and a proper boundary integral formulation leading to integral equations of the second kind (called the completed double-layer representation) is developed. Some advanced concepts of functional analysis and operator theory are used to explain the procedures, and the book also provides adequate references for background reading. All this discussion is geared towards developing convergent iterative methods of solutions that can be carried out on parallel processors: each particle is assigned to a different processor, the problem is solved locally, and the processors communicate every few iterations to let the other processors know about the local behavior of the flow. The authors are generous enough to make computer programs available to the public (but note that there is an update on the procedures).

I highly recommend this book as a text for an introductory or advanced course on colloidal science, low-Reynolds-number hydrodynamics, boundary integral methods, or advanced scientific computing. Furthermore, in the opinion of this reviewer, the book belongs on the bookshelf of any chemical engineer who has a direct or a peripheral interest in fluid flow.

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**ERRATA**

There were several errors in the spring-issue article detailing the history of the Corcoran Award:

- The venue for the first Corcoran Award was the Division banquet in the University of Cincinnati ASEE meeting, not the Lake Tahoe meeting (which was the venue for the second award to Bob Bird).
- Richard Felder's award-winning paper was "The Generic Quiz" [CEE, 19(4), 176 (1985)] and not his paper on cheating, which was mistakenly cited.
- Table 1 also listed E. Dendy Sloan's affiliation as Colorado State University when it is, in fact, the Colorado School of Mines.

We apologize both to the individuals and to our readers for the errors.
FUNDAMENTAL PRINCIPLES OF POLYMERIC MATERIALS, 2nd edition.
by Stephen L. Rosen
Wiley Interscience, 420 pages (1993)

Reviewed by
Kyu-Yong Choi
University of Maryland

This book is a revised version of the book with the same title that was published in 1981. The major target audience would be senior-level undergraduate chemical engineering students and industrial engineers who do not have prior background in polymers but who do have fundamental chemical engineering knowledge.

One visible change in the revised edition is that many exercise problems have been added to each chapter. With fully worked-out example problems, the addition of these exercise problems makes the book attractive as a textbook. While there are several undergraduate-level textbooks on polymer science and engineering, this one stands out because of these examples and exercise problems. Undergraduate students, in general, like textbooks with many examples.

The style of the author's writing is more like that of a classroom lecture. Many interesting and humorous examples and analogies are sprinkled throughout to help readers understand difficult basic concepts. I found the reading of this book very entertaining. The materials are presented in a very concise manner and important physical and chemical concepts are presented clearly. For senior-level chemical engineering students or practicing engineers with appropriate knowledge in reaction kinetics, thermodynamics, and mathematics, there should be no problem in studying this book with very little help.

The book consists of our parts: Polymer Fundamentals, Polymer Synthesis, Polymer Properties, Polymer Technology. The first part comprises seven chapters that cover types of polymers, bonding in polymers, stereoisomerism, polymer morphology, characterization of molecular weight, polymer solubility and solutions, and transitions in polymers. It should be noted that conceptual understanding of difficult concepts has been stressed throughout the book, and the manner in which the subject materials are presented is excellent. For example, in Chapter 8 ("Polymer Solubility and Solutions"), the concepts of Flory-Huggins model, solubility parameter, and its physical significance are explained in easy-to-understand language with minimal use of mathematical equations. This approach has an advantage in that students are not overwhelmed by complex mathematical derivations.

In the second part ("Polymer Synthesis"), both step growth and chain growth polymerization kinetics are discussed. The depth of the theoretical discussion of these topics is adequate, and a few numerical examples are also presented. In the chain growth polymerization part, heterogeneous polymerization systems including emulsion polymerization and transition metal catalyzed olefin polymerization are discussed in some detail. In particular, olefin polymerization kinetics, which in many other textbooks are not well covered, are presented with some recent literature on the topic.

Chapter 13 is devoted to the discussion of industrial polymerization processes. This chapter is somewhat short, but descriptive, and the examples chosen by the author are good in that the students can understand the process characteristics using the knowledge gained in earlier chapters of Part 2. This chapter offers some interesting problems for senior students looking for problems for their design courses.

Part 3 covers rubber elasticity, viscous flow, viscometry and tube flow, continuum mechanics, and linear viscoelasticity. In general, senior undergraduate students take elementary transport phenomena courses before taking the polymer course—thus the theoretical development in polymer solution or melt rheology in Part 3 looks quite reasonable for those students. Chapter 17 ("Introduction to Continuum Mechanics") is shorter than other chapters, but it offers enough advanced material for the book's readers to think about. Chapter 18 on linear elasticity is quite thorough and serves as an excellent reference for basic theories of linear elasticity.

Finally, in Part 4, various topics related to polymer processing, plastics, rubber, synthetic fibers, surface finishes, and adhesives are discussed in a descriptive manner. Although many of the chapters in Part 4 are short, each one gives a good list of pertinent literature for more advanced study.

In summary, the book is an excellent textbook covering almost all the basic materials for senior-level undergraduate chemical engineering students. The strengths of the book can be found in its coverage of a wide variety of important topics, its well-organized presentation, its few typographical errors, its technical accuracy, its many worked-out examples and exercise problems, and its reader-friendly writing style. All of the book's subjects can be easily covered in an one-semester, three-hours/week course. As Professor Rosen states in its preface, the book can serve successfully as a textbook as well as a self-study guide for practicing engineering and scientists. No solution manual is available for instructors, but a two-page errata (typographical) is available from the author. □
fluid, or a more dense particle suspension. All of these factors would enlarge the difference in settling times.

STUDENT PERSPECTIVES

The following written comments demonstrate the students' perspectives on the projects:

- Our project provided us with a lot of good experiences. One of these was simply working together to brainstorm, research, write, and present the project.
- ... gives an appreciation for fellow colleagues' imaginations and a change of pace by learning from students instead of a professor.
- Finding or estimating these values on our own gave me a better understanding of what these numbers really mean and how useful they really are.
- The most fun and educational part of the whole project was the freedom we had in defining our problem and designing our solution.
- The projects were a welcome relief from the usual homework assignments.

PROFESSOR'S PERSPECTIVE AND CONCLUDING REMARKS

These team projects were an outstanding success. By choosing novel designs to meet practical problems, students could see that engineering is simply a codification to describe mathematically what goes on everywhere around them. Because a high score absolutely depended on a creative and yet quality design, a spirit of comradery and excitement was established among the groups. Each knew that others were actively engaged in constructing hilarious prototypes, or in obtaining quality data. Even in this eight-o'clock class, one could feel the energy build as students arrived in lab coats and goggles, or with some fanciful construct veiled with a cloak. Not willing to be outdone, team members spent long hours in preparation for "their day" as they sought to ascertain that engineering principles were really at work and that their calculations were indeed meaningful.

To assure points for originality, groups interjected such things as candy bar intermissions or passed around cups of ice cream. Since they were having so much fun, the students didn't at first realize just how much they learned, nor how much time they had really spent on their projects. Finally, recruitment of student volunteers as coauthors encouraged some to further reflect on what was learned and whetted their appetite for a yet higher quality of presentation. As to continuing in this vein of instruction, this professor will certainly use the method again.

ACKNOWLEDGMENTS

The authors are grateful for the work of Andrew Au (class member) and Lance Snowhite (Columbia Basin College Instructor) in helping to prepare the figures for this publication.

REFERENCES


ChE book review

PRESSURE SWING ADSORPTION

by D.M. Ruthven, S. Farooq, K.S. Knaebel
VCH Publishers, New York, NY; 352 pages, $95.00 (19940

Reviewed by
Ralph T. Yang
State University of New York at Buffalo

Industrial adsorption processes employ fixed beds of sorbents which need to be regenerated so they can be reused. The conventional approach for sorbent regeneration is heating to desorb the adsorbed molecules, followed by cooling to the initial temperature to form an adsorption-desorption cycle, referred to as temperature saving adsorption. Due to the large sizes of the beds used in industry, however, the regeneration step is very time-consuming, usually adding hours to the duration of each cycle. Desorption can also be accomplished by depressurization and subsequent repressurization, which can be achieved in minutes. Such a cycle is called pressure swing adsorption (PSA). Since the sorbent capacity is used more frequently in PSA, it is a more efficient process. This is the major reason that adsorption has received renewed interest during the past two decades and has now become a major tool for separation and purification in the chemical and petrochemical industries.

This book provides a thorough review of the subject. It discusses the underlying principles as well as present and possible future applications. Modeling is an important aspect of PSA because it not only guides design but it also predicts feasibility of new applications. Nearly half the text is devoted to mathematical modeling for this reason. The book consists of eight chapters and three appendices:
1. Introduction
2. Fundamentals of Adsorption
3. PSA Cycles: Basic Principles
4. Equilibrium Theory of Pressure Swing Adsorption

Chemical Engineering Education
5. Dynamic Modeling of a PSA System
6. PSA Processes
7. Extension of the PSA Concept
8. Membrane processes: Comparison with PSA

Appendix A. The Method of Characteristics
Appendix B. Colection Form of the PSA Model Equations
Appendix C. Synopsis of PSA Literature

Several excellent monographs on adsorption processes are already in print, covering much of the materials in pressure swing adsorption. This new book is, however, the first one to focus specifically on the subject of PSA. From my own vantage point, its most notable features are the treatment of PSA dynamics and its cyclic behavior by the method of characteristics, and the comparison between PSA and membrane separations.

The book is co-authored by highly accomplished researchers in the field who reside in three different countries. The fine quality of the final product is an indication that the three-way collaboration has worked well.

I would highly recommend Pressure Swing Adsorption as a reference book for any advanced graduate course on separations. Needless to say, anyone working on PSA should own a copy of this book.

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**ChE book review**

**BIOPROCESSING**

_by Owen P. Ward_

Van Nostrand Reinhold, 7625 Empire Drive, Florence, KY 41042; 198 pages, $52.95 (1991)

Reviewed by

Peter J. Reilly

Iowa State University

This slim book is a comprehensive treatment of the various processes that are used to make commercial quantities of biological materials. The author, an Irishman transplanted to Canada, is Industrial Research Professor in Microbial Technology at the University of Waterloo.

Although advances in making formerly unknown molecules or in making known molecules, but from new sources, by biological means has captured the attention of both scientists and the general public, the scaleup of the methods to produce these molecules is still of prime concern. Even when achieving the lowest possible price is not the most important consideration, as with pharmaceuticals and other medicines, there is growing pressure to cut processing costs and to make purer materials. This is the province of bioprocessing, the area covered in this book.

*Bioprocessing* is composed of twelve chapters that range from what is commonly considered biochemical engineering all the way to standard food processing. Each chapter is divided into sections of one to several pages that cover different topics, and each ends with an extensive list of references for further reading. A list of the chapter titles is as good a way as any in such a wide-ranging book to described what is covered:

- Biomaterials and Bioprocessing
- Bulk Bioprocessing Operations
- Bioreactors in Bioprocessing
- Biochemical Separations
- Sterilization and Preservation in Bioprocessing
- Bulk Bioprocessing of Animal and Plant Materials
- Purification of Fine Chemicals from Non-Microbial Sources
- Fermentation and Cell Culture Processes
- Recovery of Cell Products
- Enzyme Bioprocessing Applications
- Waste Treatment
- Good Manufacturing

The treatment of the material in *Bioprocessing* is entirely descriptive; a few viscosity and heat transfer equations appear in the second chapter, but no others follow. Instead there are many figures and some tables presenting different pieces of equipment and process flow sheets, along with some generalized experimental data. Given that so many areas are covered in so few pages, there is little explanation of the basic material. Facts inexorably follow facts, making this book difficult to read in large gulps. The difficulty is compounded by the rather stodgy appearance of the book—it would have benefited from typefaces and graphics with more flair.

Where does such a book find its niche? In this case, the niche is not as a textbook. The treatment is not at all theoretical or mathematical, prerequisites for any text used by engineers. On the other hand, *Bioprocessing* is not a review of a specific area; it spreads over too much terrain. Although it has extensive lists of other articles and publications at the end of each chapter, it has few references to other work within its text, so tracking down more detailed information on any particular statement would be a hit-or-miss proposition.

It is probably best employed as a primer—for finding the first information about a new topic and acting as a starting point to dig deeper. For this, *Bioprocessing* is admirably suited: each topic is concisely covered, there are a great number of topics, and the index at the end is very comprehensive, making each topic easy to find.